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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/626,748	07/22/2003	Chang Hee Nam	03-486	1728

34704 7590 01/26/2005

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EXAMINER	
THOMAS, COURTNEY D	

ART UNIT	PAPER NUMBER
2882	

DATE MAILED: 01/26/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/626,748	NAM ET AL.	
	Examiner	Art Unit	
	Courtney Thomas	2882	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 July 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-11* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-11* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *22 July 2003* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

1. The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609 A(1) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have been cited by the examiner on form PTO-892, they have not been considered.

Drawings

2. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the (X-Y) actuators (claim 10) must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the

drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

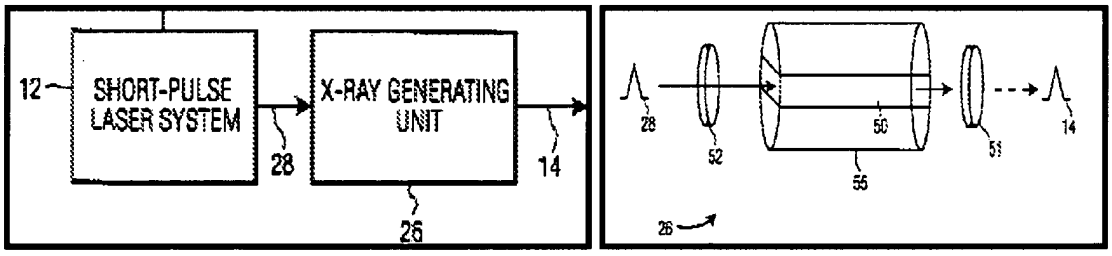
Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nelson (U.S. Patent 6,349,128) in view of Yang et al. (U.S. Patent 6,706,154) and Dawson (U.S. Patent 3,961,197).

5.



Figures 1 and 2 – X-ray generating system – U.S. Patent 6,349,128 to Nelson

6. **As per claim 1**, Nelson discloses an X-ray generating apparatus (**12, 26**) for generating a coherent high-order harmonic X-ray beam (**14**) comprising: **a**) a high power femtosecond laser (**12** - column 1, lines 41-43) and **b**) a gas filled hollow tube target (**50**) for generating a high-order harmonic X-ray beam (column 1, lines 43-49; see also column 5, lines 50-56). Nelson does not explicitly disclose an X-ray generating apparatus as further comprising a laser intensity controller and a gas pressure controller.

7.

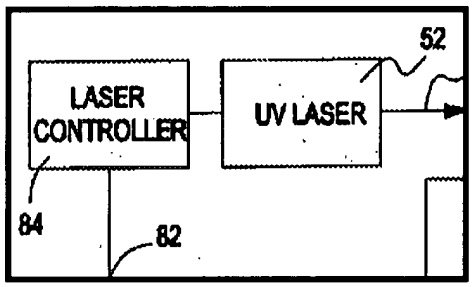


Figure 2 – Laser, Laser controller arrangement – U.S. Patent 6,706,154 to Yang et al.

8. Yang et al. teach that emission characteristics of a laser source (**52**) can be manipulated via a laser controller (**84**). In particular, Yang et al teach that beam size and laser intensity are regulated to maintain and/or achieve desired laser output parameters during device operation (column 6, lines 18-21). Those having ordinary skill in the laser art would recognize the use of a laser controller as a means for providing automated monitoring of laser output.

9.

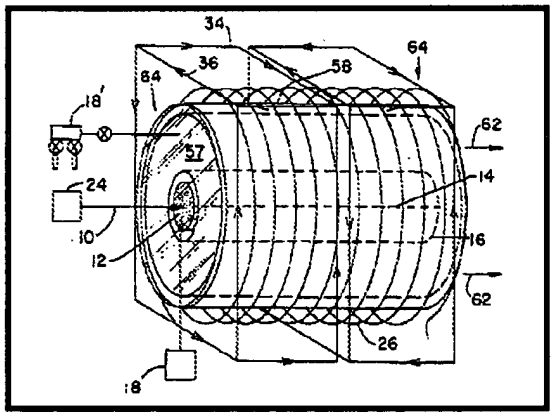


Figure 1 – X-ray generator with gas pressure control - U.S. Patent 3,961,197 to Dawson

10. Dawson teaches an X-ray generator comprising a gas pressure controller (**26**) configured to apply an opposing force (i.e. pressure) to the gasses contained in column (**12**). Dawson further teaches the pressure controller provides a stable confinement of heated gases along equilibrium axis (**14**), as laser beam (**10**) passes through the gas target material (see also column 2, lines 63-68, column 3, lines 1-22).

11. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the X-ray apparatus of Nelson such that it incorporated a laser intensity controller and a gas pressure controller. One would have been motivated to make such modifications for the purposes of maintaining and/or achieving desired laser emission characteristics during device operation as taught by Yang et al. (column 6, lines 18-21) and for stably confining the heated gases within the gas target chamber as taught by Dawson (see also column 2, lines 63-68, column 3, lines 1-22).

12. **As per claims 2 and 3**, Nelson as modified above, disclose an apparatus as recited in claim 1, but do not explicitly disclose an apparatus wherein **a)** a high order harmonic X-ray beam is generated so that a single harmonic order is dominant, by manipulating both the laser controller and the gas pressure controller and **b)** wherein the femtosecond laser pulse generates a pulse width of approximately 20 femtoseconds and the energy per pulse is approximately 0.35mJ.

13. It would have been obvious to one having ordinary skill in the art at the time the invention was made to further modify the apparatus of Nelson such that the apparatus generates a high order harmonic X-ray beam wherein a single harmonic order is dominant, by manipulating both the laser controller and the gas pressure controller. One would have been motivated to make

such a modification for the purpose of improving the intensity of the output X-ray radiation by varying X-ray generating conditions to obtain a desired spectrum for a particular goal as suggested by Nelson (column 1, lines 37-47). Furthermore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the apparatus of Nelson wherein the femtosecond laser pulse generates a pulse width of approximately 20 femtoseconds and the energy per pulse is approximately 0.35mJ. One would have been motivated to make such a modification for the purpose of generating coherent X-ray radiation through the interaction of ultra-short laser light pulses with atoms of the gas target; the X-ray radiation displaying low spatial divergence as suggested by Nelson (column 3, lines 34-45).

14. Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Medecki (U.S. Patent 5,835,217).

15.

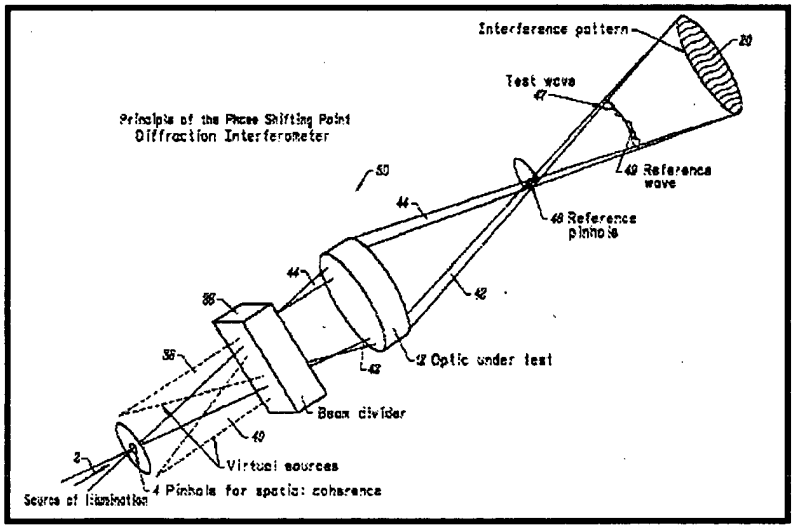


Figure 2 -Principle of Point Diffraction Interferometer - U.S. Patents 5,835,217 to Medecki

16. **As per claim 4**, Medecki discloses a point-diffraction interferometer comprising: **a)** an interferometer plate (not numbered) implemented with a thin film and having a pin-hole (**4**) and arranged perpendicular to an incident path of a source of illumination to generate a diffracted

beam forming a reference beam (**44**) and a transmitted beam (**42**) and **b**) a detector (**20** - column 6, lines 46-50) disposed on the path of the reference and transmitted beams to detect an interference pattern generated through the interference of the reference and transmitted beams. Medecki does not explicitly disclose the source of illumination is a coherent high-order harmonic X-ray beam and that the detector is an X-ray detector.

17. Medecki teaches however, that the source of illumination may be coherent or incoherent and suggests the use of a detector to meet the needs of an experimenter (column 4, lines 34-42 and column 6, lines 46-50). Medecki also posits the desire within the art to provide a reference beam with high intensity (column 3, lines 47-48).

18. It would have been obvious to one having ordinary skill in the art to modify the point-diffraction interferometer of Medecki such that it incorporated a coherent high-order harmonic X-ray beam as the illumination source and an X-ray detector. One would have been motivated to make such a modification for the purpose of providing a coherent, high intensity source to produce high intensity reference beams and a corresponding X-ray detector to detect the high intensity beams, thereby solving a long standing problem in the art as suggested by Medecki (column 3, lines 47-48).

19. **As per claim 5**, Medecki discloses a point-diffraction interferometer having an interferometer plate (not numbered, see Fig. 3 (i.e. **56**) not show above), but does not explicitly disclose the plate as being a thin foil with pinholes.

20. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the interferometer of Medecki such that the interferometer plate comprised a thin foil with pinholes. One would have been motivated to make such a modification

for the purpose of providing an opaque mask to produce multiple, spatially coherent beams from the incident radiation as suggested by Medecki (column 7, lines 54-67, column 8, lines 1-5). Examiner does not give any patentable weight to the claimed method used to form the holes in the interferometer plate, as there would be no distinguishable difference in functionality between another plate with holes made using an alternate technique (see also MPEP 2113).

21. Claim 6-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Medecki (U.S. Patent 5,835,217) as applied to claim 4 above, and further in view of Nelson (U.S. Patent 6,349,128), Yang et al. (U.S. Patent 6,706,154) and Dawson (U.S. Patent 3,961,197).

22. Prior to a discussion of the aforementioned claims, Examiner notes that the point-diffraction interferometer of claim 4, attempts to further define a source for the coherent, high order X-ray by incorporating subject matter previously addressed in claims 1-3 above. For brevity, Examiner treats claims 6, 7 and 9 as claims 1-3 as a singular concept/apparatus (coherent, high-order harmonic X-ray source). The following discussion will therefore focus on the rationale for the incorporation of claims 6, 7 and 9 into the point-diffraction interferometer of claim 4.

23. **As per claims 6, 7 and 9**, Medecki discloses a point-diffraction interferometer, but does not explicitly disclose an interferometer comprising: a) a high order harmonic X-ray source.

24. Nelson as modified above (see claims 1-3) teaches the use of an X-ray generating apparatus as a source for applications requiring coherent, X-rays of short optical pulses. Nelson further teaches that such a source produces coherent X-ray radiation, displaying low spatial divergence (Nelson ('128) column 1, lines 41-49; column 3, lines 34-45).

25. Additionally, Medecki teaches that the disclosed point-diffraction interferometer can be configured to utilize a coherent or incoherent source of illumination (column 4, lines 34-42) and posits the need for a source of high energy (column 3, lines 47-48).

26. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the point-diffraction interferometer of Medecki such that it incorporated a coherent, high-order harmonic X-ray source. One would have been motivated to make such a modification for the purpose of providing a coherent, high intensity source to produce high intensity reference beams with low spatial divergence, thereby negating the need for additional filtering elements as suggested by Nelson (column 1, lines 41-49; column 3, lines 34-45) while solving a long standing problem in the art as suggested by Medecki (column 3, lines 47-48).

27. **As per claims 8**, Medecki as modified above, discloses a point-diffraction interferometer comprising a filter (**46** - column 6, lines 40-45) disposed between the interferometer plate and detector (**20**).

28. **As per claim 10**, Medecki as modified above, discloses a point-diffraction interferometer, but does not explicitly disclose an interferometer plate movable along X and Y-axes by actuators. It would have been obvious to one having ordinary skill in the art to further modify the point-diffraction interferometer of Medecki such that it incorporated (X-Y) actuators to move the interferometer plate along x and y axes. One would have been motivated to make such a modification for the purpose of optimizing incident radiation onto the receiving detector.

29. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bartels et al. (2000).

30.

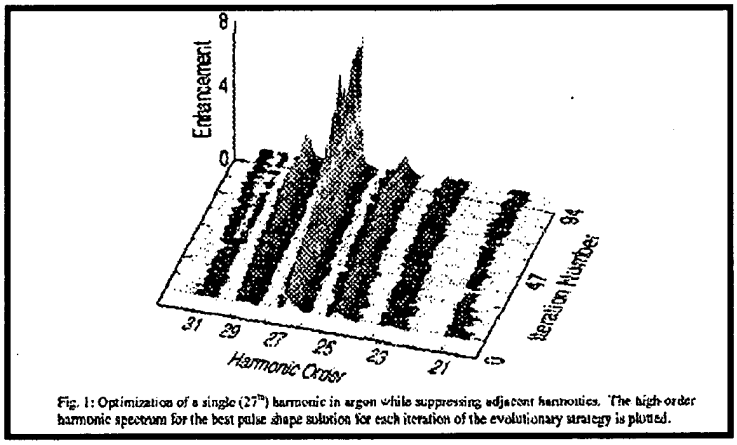


Fig. 1: Optimization of a single (27th) harmonic in argon while suppressing adjacent harmonics. The high-order harmonic spectrum for the best pulse shape solution for each iteration of the evolutionary strategy is plotted.

31.

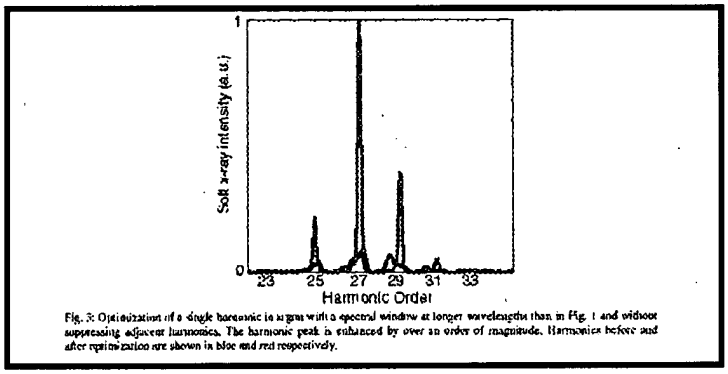


Fig. 3: Optimization of a single harmonic in argon with a spectral window at longer wavelengths than in Fig. 1 and without suppressing adjacent harmonics. The harmonic peak is enhanced by over an order of magnitude. Harmonics before and after optimization are shown in blue and red respectively.

Figures 1 and 3 – Bartels et al. (2000)

32. **As per claim 11**, Bartels et al. disclose a high-order harmonic X-ray generation method comprising the step of allowing harmonics near a predetermined order to be phase matched by adjusting the beam size of a high power femtosecond laser beam (Abstract, paragraph 1, see Figs. 1 and 3 above). Bartels et al. do not explicitly disclose a method comprising the steps of reducing intensity of long-wavelength harmonics with orders less than a predetermined order by controlling the pressure of the target gas and using an X-ray filter or reducing the intensity of short wavelength harmonics with orders greater than a predetermined order by adjusting focused intensity of a high power femtosecond laser beam.

33. Bartels et al. do however, suggest the manipulation of target gases and pressures (paragraph 6) in conjunction with manipulations of laser intensity (paragraphs 3-5) that result in significant smoothing/ optimizing of a single harmonic order, without temporal broadening. The methodology results in the creation of bright, quasi-monochromatic and highly spatially coherent X-rays (paragraph 8).

34. It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the method of Bartels et al. such that it incorporated the steps of reducing intensity of long-wavelength harmonics with orders less than a predetermined order by controlling the pressure of the target gas and using an X-ray filter or reducing the intensity of short wavelength harmonics with orders greater than a predetermined order by adjusting focused intensity of a high power femtosecond laser beam. One would have been motivated to make such a modification for the purpose of smoothing/ optimizing a single harmonic order, without temporal broadening, thereby generating bright, quasi-monochromatic and highly spatially coherent X-rays as suggested by Bartels et al. (paragraphs 3-6, 8).

Conclusion

35. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

36. Miyazaki, K. et al. (1993) **High Order Harmonic Generation in the Soft X-Ray to XUV by Ultra short Laser Pulses**; Lasers & Electro-Optics Society Annual Meeting - Conference Proceedings Nov. 15-18, 1993; pp. 758-759

37. Chang, Zenghu (1998) **Generation of Coherent, Femtosecond, X-ray Pulses in the "Water Window;"** IEEE Journal of Selected Topics in Quantum Mechanics, Vol. 4, Issue 2, March -April ('98); pp 266-270

38. Nam, Chang Hee et al. (1999) **Tunable Coherent Femtosecond Soft X-ray Source Based on High-Harmonic Generation**; Lasers & Electro Optics; The Pacific Rim Conference Vol. 1, Aug. 30 - Sept. 3 ('99); pp. 74-75

39. Bartels, R et al. (2000) **Control of High-Order Harmonic Generation Through Shaped Pulse Optimization**; Nonlinear Optics: Materials, Fundamentals and Applications - Technical Digest, Aug. 6-10, ('00); pp. 289-291

40. The aforementioned references disclose developments in the generation of High Order Harmonic X-rays using ultra-short laser pulses.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Courtney Thomas whose telephone number is (571) 272-2496. The examiner can normally be reached on M - F (9 am - 5 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ed Glick can be reached on (571) 272 2490. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Courtney Thomas

Courtney Thomas
Examiner
Art Unit 2882